Bombing Policy in the Rome and Pre-Normandy Invasion Aerial Campaigns of World War II:

Bridge-Bombing Strategy Vindicated — and Railyard-Bombing Strategy Invalidated

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A debate which never should have taken place, whose circumstances never were clarified, and whose results never have been adjudicated, has been going on since the latter part of World War II about the proper role of air power in supporting a breakout or an invasion.[1] This debate recently intensified with the 1978 publication of the Zuckerman memoirs,[2] and the consequent efforts to reply to them in *Encounter* by Charles P. Kindleberger[3] and Walt W. Rostow[4] in 1978-80. Much light could be cast on this situation, if a "think-tank" report for the United States Air Force, available since 1972, and a compilation of declassified secret-war revelations,[5] published in 1976, were consulted. However, even those works did not evaluate the 1943 Zuckerman claim that bombing marshalling yards (usually found in big cities) was more "efficient" than bombing bridges (usually found in the countryside, or at least not in the heart of a city).[6]

Nor did either arbitrate Zuckerman's analysis of Sicilian-Italian bombing raids, which occurred in brief, earlier periods ending 5½ and 6½ months, respectively, before the campaigns to break out and capture Rome and to invade Normandy commenced. Yet it was this analysis on which all the Zuckerman theories — adopted by Air Marshal Sir Arthur Tedder in both theaters — were based. And all the debate then and since has been on how to evaluate Zuckerman's analyses and recommendations.[7] It is a pity that the rest of the Rome campaign, the whole of the pre-Normandy-invasion operations, and the latter part of World War II then proceeded without any authoritative assessment of the relative effort required and relative success obtained: i.e., the costs (in delays, treasure, and blood) versus the (military) benefits, if any, of the two kinds of air attack.[8]

It is also surprising that Zuckerman's criterion of "efficiency" ever was considered in planning such emergency operations as the break out from a stalemate or the support of a water-borne invasion. The big questions in those crisis situations always should have been, "*Can* it be done? If so, how?" rather than, "How efficient would it be?" So has it been back to the earliest days of antiquity.

Only when wars of attrition against industrial superpowers required it, did strategic-bombing campaigns — e.g., campaigns against oil or armaments industries, or possibly against population or transportation centers — become options; and "efficiency" begin to enter the picture. Unfortunately, there do occur watershed points, like the impasse at Anzio/Cassino, or the early 1944 period of trying to bomb everything before D-Day in Normandy. At these junctures, a supreme command's air forces never are enough to do everything, and a choice has to be made between strategic and ground-support aerial efforts, in particular.

Here, where isolation of the battlefield, or at least interdiction of rail and road routes to it, becomes imperative, history has shown how tactically important are rivers and ravines, and the bridges over them. The essential point turns out to be that only one railroad track is needed to bring up troops, tanks, and supplies. Such a track can be reopened in a few *hours* through a bombed-out marshalling yard, whereas *weeks* normally are required to reconstruct a collapsed heavy railway bridge, 11 weeks in the case of the Recco Viaduct in Italy.[9] My purpose in writing this article is to arbitrate the issue once and for all, and at the same time to reveal the delay and destabilization of Allied air-war operations which was caused by these misunderstandings.

How a Marshalling Yard Bombing Strategy was Imposed in Italy

It should be noted that the recently-renewed debate is only a continuation of the sharp disagreements previously arising between the same parties 37 years ago in the U.K., regarding whether to bomb marshalling yards (M/Ys) or bridges before invading Normandy. It can hardly be by chance that the Zuckerman autobiography (which covered almost every other aspect of these matters) practically left out the equally profound, but earlier, disagreements starting in June 1943, involving its author and another set of opponents, dealing with the same issue, but in the Mediterranean (Sicily and then Italy). Apparently as early as August 1943, the anatomist and natural-science professor, then Scientific Adviser on planning to Tedder, commander of Northwest African Air Forces (NAAF) decided on the basis of early "empirical" evidence he had gathered and interpreted on the Sicilian bombing, that there was a greater return in bombing nodal points (yards) than in bombing bridges: "Railway and road bridges are uneconomical and difficult targets and in general . . . not . . . worth attacking."[10]

On this basis, and passing over widespread opposition in the theater — including a contrary recommendation on the very same date from his own Target Intelligence Section — Tedder, in a 24 December 1943 directive, banned the bombing (by either American or British air forces) of *all* targets within either of these two categories (M/Ys and bridges) throughout Italy, except for seven rail-center M/Ys in the central and far northern reaches of the country.[11] These were mostly far behind the front, which then was slowly approaching Cassino.

This ignored three facts: first, that Generals Kuter and Marshall at the Pentagon already in late October had vainly recommended bombing 16 bridges in those areas, advising Roosevelt and notifying Eisenhower to that effect; second, that bridge bombing just north of Rome, by heavies and mediums, recommended by General Partridge of NAAF on 6 October, had almost forced an enemy abandonment of Rome, when tried briefly under Tedder's deputy, General Spaatz, in October-November; and third, that Eisenhower had just briefed the Chiang-Kai-shek — Churchill — Roosevelt conference at Cairo in late November on the possibility of breaking the Italian-front deadlock by such *line-of-communication* attacks, using air power. Putting the ban into effect, Tedder (with his adviser) then left the theater, one week later (31 December) to become Eisenhower's over-all deputy commander for the Normandy invasion.[12] Thereupon, NAAF was renamed Mediterranean Allied Air Forces (MAAF), under General Ira Eaker.

Bridge Bombing Succeeds in Italy in Five Days

After the Tedder/Zuckerman departure, the opposition in the Mediterranean merely became fiercer than ever (from Algiers

to Caserta, Italy, and embracing Tedder's successor [Eaker] and Spaatz again, when the latter flew back in for a visit from the U.K.). Finally, the debate became academic in the Mediterranean, because M/Y bombing became a dead issue there, after 19-24 March 1944.[13]

In those five days, MAAF's medium bombers attacked "the whole system of bridges, yards, etc." (mostly bridges) behind the German front "simultaneously," thereby cutting all the through rail traffic to Rome and also to the Cassino front. Thereafter, Allied medium, light, and fighter-bombers kept the rail system cut. Then they disrupted the substitute road traffic, and cut up enemy reserve tank divisions en route (coming from the north), right through to the capture of Rome, 4 June, two days before D-Day in Normandy. Sallagar, in his 1972 report for the USAF, calls this operation "STRANGLE," "one of the outstanding campaigns of World War II," which "contributed immeasurably to the defeat of the German armies," and which "proved [that] the opponents of attacking M/Ys [were] right," because "traffic from Germany never stopped, as M/Y damage was repaired quickly."[14]

I was an intelligence specialist at NAAF and MAAF Hq Target Intelligence Sections during the last six months of the Rome campaign, had meditated for several weeks about the Zuckerman theories (so enchanting to NAAF and MAAF operations stafffs), and had hastily written a three-page memorandum on 16 March 1944. It warned at the outset that a "ground emergency" impended, which automatically would yield control of MAAF heavy bombers to the theater ground commander — and was the very last thing that Eaker wanted.[15] It also reminded that not just the Operations Assistant Chief of Staff (ACS) but also the Intelligence ACS were responsible for making situation estimates for the Theater Air C-in-C. It may have precipitated the decision to resume bridge bombing 72 hours later.

Agreements and Disputes

Much credit *is* due Zuckerman, the professor of natural science and later consultant to the U.K. Ministry of Home Security, for having shown "empirically," with live animals, how to minimize civilian air raid shelter casualties and stiffen resolve before the Battle of Britain. But does that entitle him to gainsay, even unwittingly, all military doctrine and historical precedent, such as commanders capitalizing on enemy vulnerability to attacks on bridges to their rear, the weak points in their supply and retreat routes? And is not his behavior, over 38 years now of debate, suspect for (as Kindleberger says) "protesting too much that he is right?"

He never answers the charge that a M/Y blockage can be overcome in a few *hours;* but a bridge-cut, only in up to several *weeks*. This charge disposes of his argument that "any bomb on a railway centre causes damage," whereas "only a direct hit counts [sic] on a bridge."[16] Also, is he not unnecessarily contentious (he tells of contradicting Eisenhower on the statistical probability of winning a long-shot poker play) and unwarrantedly disputative (he admits answering Churchill sarcastically, about not being a railway expert, at a 15 April 1944 council-of-war meeting)? He does not agree with Kindleberger now, because Kindleberger was inacurate on a few minutiae (e.g., he was not wrong that the British railway experts said that blocked M/Y traffic could be reopened quickly, but only wrong in that *their remarks* to that effect were not included in the record). In his autobiography, he does not accept responsibility for early estimates, at Churchill's "midnight follies," that his M/Y offensive could cause 40,000 French and Belgian civilian fatalities — up to 160,000 total casualties, Spaatz wrote to Eisenhower. Some of his coterie had made that estimate, not he. (Churchill at that time had called the plan cold-blooded butchering.)

In the same book he rushes to minimize — at 10,000 killed and wounded — the final casualty tally of the pre-November M/Y-bombing campaign, by taking refuge in an inadvertent mention of that number of "casualties" in the *AAF History* (III, 79), where "fatalities" clearly must have been meant. (No less than 6,062 French *dead* had been tallied at M/Ys only halfway through May — the month of the heaviest preinvasion M/Y bombing, according to Brown [519], citing "documents concerning French civilian casualties," in Operations & Plans Division files, Modern Military Records, National Archives.)

In his last piece, rebutting Rostow, he does not accept responsibility for M/Y advocates earlier having said that blockage of the Seine River bridges would require 1,200 tons of bombing per bridge. A supporter, Mr. Brant, had said that. Finally, he disputes Rostow's claim that the M/Y offensive delayed Spaatz's oil target programs by at least two months (but the bomber forces massed by Spaatz were diverted to, and used by others for, the M/Y attacks instead, most of them at that time, and some of them off and on for the rest of 1944, at least). "Spaatz," he says, "was party to all decisions taken at that time."[17]

Yet Spaatz was not known as one who failed to obey and carry out unwelcome orders. Also, the record shows that Spaatz, Air Marshal Sir Arthur Harris, and General H. H. Arnold had protested against the offensive in February 1944. The record also shows that Spaatz himself had exhaustively repudiated it in early March, and had stated then, and again in a "final," impassioned "plea" to Eisenhower on 25 March, that "interdiction [bridge bombing] could seal off the Normandy area" and release "surplus bombing effort to" oil-refinery attacks and "other worthwhile campaigns," thus producing "decisive effects within six months." In contrast, he said, the M/Y plan "could not be decisive within any measurable length of time." Spaatz had even sent for Eaker, who strongly advised Eisenhower against the plan.[18]

Maybe it eats at one's conscience that Churchill finally appealed to Roosevelt (over Eisenhower's, Tedder's, and thus Zuckerman's heads) against the M/Y campaign, which Zuckerman had advocated at his councils-of-war. Could Tedder and Zuckerman possibly have been wrong? And could all the others — Churchill, Arnold, Harris, Spaatz, AAF headquarters (which "tended to follow Spaatz's views") Eaker, Slessor, others in the Mediterranean and most everybody else with an open mind and no "position taken" to defend — in both theaters and in the Pentagon, possibly have been right? Let us look at some other data and facts in evidence. Most of them have not been singled out, compiled, and made available previously to the general reading public, or researched and analyzed by historians. They alone will show which policy was right.

Rome Campaign: M/Ys Prove Three Times as Difficult to Destroy

Contrary to Zuckerman's interpretation of the September-October 1943 rail bridge attacks in South Italy by heavy and medium bombers, OSS/Italy's interpretation of Zuckerman's own report's data was that 100 tons or more dropped in 2½ raids on a bridge would have "very high chances indeed of securing a [50 percent] blockage." OSS found, from data on such attacks by heavies and mediums, terminating three months later than Zuckerman's data, that "the average weight of bombs dropped per blockage [actually] produced was 196 tons (as against 428 tons for a M/Y)." It concluded that MAAF was strong enough to succeed in Italy with a full scale bridge attack campaign, but could not mount an M/Y campaign on the scale necessary to "produce significant military results."[19]

Right after 19 March 1944, MAAF's heavies pummeled ten distant North Italian large city M/Ys, with an estimated 5,000 tons all told, while its mediums decisively cut or blocked trunk lines, primarily at 41 nearby rail bridges, with an estimated 7,150

tons.[20] But it was the bridge attacks which brought success, with an estimated average of 175 tons actually delivered per bridge — against an estimated average of 500 tons, nearly three times as much, actually delivered (dissipated) per large city M/Y. As to results, the 78-day bridge busting campaign was "an unqualified success" and "dealt the German armies a crucial blow," according to Sallagar (xiii, vi). Aircraft, aircrew, and civilian losses were probably relatively negligible, since few aircraft and personnel are casualties in bridge bombing, especially in open country. The benefits were very high; the costs, relatively low.

But the M/Y bombing cost perhaps the loss of 20 aircraft— all heavy bombers — and 200 of the possibly 3,600 aircrew deaths incurred in the capture of Rome,[21] as well as brought about 1,000 Italian-civilian deaths at or near the yards. (I apply the tonnage: civilian-fatality ratio ruling in the later, pre-Normandy-invasion attacks, and add an extra half for the greater population-density of the Italian cities hit.) Furthermore, maybe 3,000 (*three times* 1,000) civilians — using Spaatz's implied ratio (above) — would have been wounded on the ground in these attacks. The benefits, as already noted, were minimal; the costs incurred, very high all around.

Normandy: M/Ys Become 6½ Times as Difficult Targets

Zuckerman had the misfortune to admonish Kindleberger to read Harrison,[22] only to have Rostow then quote Harrison (228) back to him, to the effect that only 220 tons actually were used, on the average, to demolish the Seine bridges. Even at that, Harrison must have assumed that only 20 bridges — and just bridges on the Seine — were knocked out up until D-Day. Dividing the 4,400 tons dropped on French-Belgian bridges by 20, tons dropped by mediums and fighter-bombers in this period, according to *AAF History* (III, 159-160), does yield 220 tons per bridge destroyed. However, one must go further. Dividing the tonnage dropped by 36 — *AAF History's* reported "12 railway and 14 highway bridges made impassable over the Seine" (III, 159) *plus* the Zuckerman autobiography's 10 others destroyed as far east as Liege in Belgium (257) — means that only 120 tons actually were dropped per bridge blockage produced in these operations to 6 June. This is way below "Mr. Brant's" contentions, and well below the actual score in the Rome campaign of 175 tons.

On the other hand, *AAF History's* reported tonnage dropped on French-Belgian-Dutch-Luxemburgian-German targets in the M/Y campaign, 71,000 tons (III, 155), when divided by the Zuckerman autobiography's 93 M/Ys effectively bombed (256) to support the invasion, reveals that 765 tons actually were delivered (or dissipated) per M/Y blockage (effective bombing) attempted up to D-Day. This is almost 6½ times the tonnage dropped to produce a bridge blockage in this campaign.[23] As to results obtained with these two strategies in supporting the Normandy invasion, no Sallagar yet has unscrambled them and assessed their relative benefits separately, though *AAF History* (III, 156) called the bridge campaign "probably decisive."

However, while the attacks on the railway system cut France's total traffic by 77 percent by mid-July (III, 160), the Germans always could have commandeered any of the remaining rail capacity they needed for military use to and in the combat area. They needed only 20 percent according to British railway experts (III, 76). Anyway, Zuckerman had promised that his M/Y campaign would stop all rail traffic in 90 days, which it never did! The benefits here thus were nebulous, if not even counterproductive.

In the event, the M/Y bombing, which reached 33,000 tons by 30 April (III, 153), caused the loss of probably 300 aircraft, mostly heavy bombers; and caused maybe 3,000 of the 12,000 aircrew deaths which occurred in the pre-invasion (1 April - 5 June) operations.[24] As mentioned above, it caused about 10,000 M/Y-city deaths among civilians (12,000 civilians died in *all* air attacks in the same period). Already, before 24 May, the French cardinals had appealed to the Anglo-American episcopates to halt the campaign (Brown, 519, 523). Maybe 30,000 (*three times* 10,000) civilians would have been wounded in these attacks. These were astronomical costs, especially in view of the dubious benefits already noted.

On the other hand, "the line of [bridge] interdiction along the Seine was a fact" before D-Day according to *AAF History* (III, 159). The attacks on bridges included 38 more over the Loire, etc., destroyed *on D-Day itself*, to "isolate the battlefield," according to Murphy.[25] These attacks, according to Brown, would have kept off six of the seven dreaded German panzer divisions, rushed from strategic reserve by Hitler to cross the rivers of France and mass at the beachhead in the critical first 18 days.

The seventh, the famed, over-strength "Das Reich," with its own bridging train (n.b.) was stopped, both by debilitating guerrilla attacks and the division's own mass atrocities against French civilians, and by the bombed bridges (and one bombed tunnel) at the Loire, from being other than too little and too late. It has been calculated that the prompt arrival of just one more fully equipped, unweakened, over-strength panzer division, to join the four other more-or-less complete ones already on the beachhead perimeter (over the bridges), would have turned the invasion back into the water.[26] Again, for bridges, we see very high benefits with relatively low costs.

Countable Results of Two Types of Bombing Operations in Two Major World War II Aerial Campaigns

Campaign Targets	Rome Campaign* 19 March - 4 June 1944 vs. Bridges	vs. Yards	Pre-Normandy Invasion Campaign* 1 April - 5 June 1944 vs. Bridges	vs. Yards
Tons Dropped	7,150	5,000 **	4,400 +	71,000
Ditto, per Target	175	500 **	120 +	765
Targets Damaged ++	41	10 **	36 +	93
Aircraft Lost	N	20E	N	300E
Airmen Killed	N	200E	N	3,000E
Airmen Wounded	N	200E	N	3,000E
Civilians Killed	N	1,000E	N	10,000E
Civilians Wounded	N	3,000E	N	30,000E

* By comparison, 60,000 tons were estimated dropped against targets of all kinds in the Rome campaign's 78 days, and 200,000 were reportedly dropped against targets of all kinds in the pre-Normandy-invasion campaign's 66 days (up to the eve of D-Day).

** Attacks by heavy bombers, on North-Italian big-city yards, only (In nine attacks by medium bombers, on medium- and small-city yards in the Rome-to-Florence area of Central Italy, possibly 3,600 additional tons were dropped, at possibly 400 tons per yard.)

\+ In attacks on D-Day itself, on 38 other bridges, etc. (including one tunnel) at the Loire, etc., possibly 4,560 additional tons were dropped, at possibly 120 tons per target.

++ Other beneficial consequences of these operations on the prosecution of the war are not directly countable. However, bombed bridges kept enemy tank reserves from reaching the front in both campaigns. In both campaigns, smashed railyards failed to stop through military traffic, and concentration — from the beginning — on railyard bombing lengthened the war by almost three months. (See text)

N Not known, but believed negligible. (See text)

E Estimated by Lytton from data in *AAF History, MAAF History,* Sallagar, Brown, others; from total tonnages of bombs dropped against targets of all types and by types of target, average bombloads per type of bomber and by type of target, total sorties (aircraft flights) made against targets of all types and by type of target, numbers of aircrew per various types of bomber, number of civilians killed per ton of bombs dropped in pre-Normandy-invasion railyard bombing, assumed 50% greater population density and ⅔rds greater intensity of anti-aircraft opposition at North-Italian railyard-cities attacked, and implied 1:3 ratio of dead to wounded civilians on the ground during railyard attacks (and assumed 1:1 ratio of dead to wounded airmen in such attacks). (See text)

Conclusion

All of this suggests that it is perilous (it may hold up a war) for any natural scientist or air marshal to turn "from apes to warlords" too offhandedly and too confidently — i.e., to turn too freely from analyzing empirical evidence on purely biological matters to planning operations in the highly complicated world of conventional aerial warfare. It is perilous also to forget, as Kindleberger underlines now, and as I pointed out in opposing

Zuckerman's approach on 16 March 1944, that testimony obtained during interrogation of willing interrogees can depend upon how you frame your questions.[27] Or, finally, it is perilous to stick with *statistical probabilities*, based on fleeting, early data, for bridge attacks originally carried out by heavy bombers and expect them to be a better policy guide for the future than *actual results* obtained in that future (five to seven months later) by fighter bombers, making lower flying, more sophisticated, more accurate strikes.

With after-the-fact bridge busting feasibility data like those cited above (South Italy campaign, 196 tons; Rome campaign, 175 tons; Normandy campaign, 120 tons), which must have been available to him at all times from his friendly operations-research/analysis units, it is no wonder that the scientific adviser still chooses to take refuge in empirical evidence, gathered and now interpreted (with maximum statistical probability) by him, from early Sicily-Naples campaign data: his last *Encounter* article's 360-540 tons estimated requirement to destroy a bridge. It is no wonder that he never calculates the higher costs, lower benefits, and 3-to-6½ times more costly requirements to block or effectively bomb a M/Y.

Lastly, it is no wonder that, in answering Kindleberger in *Encounter* (June 1979, 88), he avoids any discussion of the relative return from the admittedly lucky 7 May 1944 raid on the Seine railway bridge at Vernon. That "notable operation . . . wrecked" the 725-foot-long steel girder target, with just 8 tons of bombs dropped by eight low-skimming Thunderbolt fighter-bombers (*AAF History*, III, 158; Brown, 522). While Zuckerman still claims 35 years afterwards that the raid was just an experiment, it turned out to be a quite instructive event, as "it swept away all serious doubts" in the mind of Zuckerman's own AEAF commander, and caused the latter to order bridge attacks started (as Field Marshal Montgomery had requested) three days later (*AFF History*, III, 157-158). It must also have been all-too-impressive a demonstration to none other than Field Marshal Rommel, who was an accidental onlooker at the scene that day, as now revealed by Brown.

REFERENCES

1. Basic sources of this paper are W. F. Craven and J. L. Cate (eds.), *The United States Army Air Forces in World War II* (Chicago: University of Chicago Press, 1951), II & III (hereafter *AAF History*); and Hq, Mediterranean Allied Air Forces (MAAF), *"STRANGLE" and "DIADEM"*, 1944 (a condensed version of the narrative portion of Hq, MAAF, *MAAF Operations in Support of "DIADEM"*, 1944, 7 vols.), on file at Office of Air Force History (OAFH), Washington (hereafter *MAAF History*). I commenced research on this issue in late 1973, after discussing with the late Admiral Samuel Eliot Morison, WWII Naval historian, the dearth of relevant operational statistics in military histories on these historic air bombing campaigns.

2. Solly Zuckerman, *From Apes to Warlords: The Autobiography (1904-46) of Solly Zuckerman* (London: Hamish Hamilton Ltd., 1978). Professor Zuckerman, an anatomist, was Scientific Adviser on planning to the Allied Northwest African Air Forces (NAAF) and predecesor commands, and later to Supreme Headquarters Allied Expeditionary Forces (SHAEF) and the Allied Expeditionary Air Forces (AEAF), during the periods discussed here. His autobiography reveals how he was impelled to make his own post-aerial-attack bomb damage surveys on the ground (once evacuated by the enemy), make his own post-attack air-photo-cover interpretations, examine aerial operations summaries and captured railway traffic flow records, analyze (by his own methods) the operations' accomplishments, develop and apply his own criteria for such evaluations, and consequently (*MAAF History*, 190) recommend changed aerial strategies. This procedure reveals flawed thinking, to the extent that it allows a redeterminiation of aerial operations objectives — wholly a commander's prerogative and responsibility. That could change the *criteria* for judging an operation's effectiveness or desirability, vis-a-vis that of alternative operations.

3. Charles F. Kindleberger, "World War II Strategy," *Encounter*, 51 (Nov. 1978), 39-42, characterized Zuckerman's book as a *plaidoyer*, disputed his self-styled "empirical" approach on philosophical grounds and repeated the logical reasons which he himself had advanced in 1944 for bombing bridges, so as "tactically to support the [Normandy] invasion . . . by pushing back the railheads from the battle [area]." Kindleberger, an economist, had headed a BEW-OSS "Enemy Objectives Unit" in London. Zuckerman, "Bombs and Illusions in World War II," *Encounter*, 52 (June 1979), 86-89, replied that Kindleberger was innacurate, faulty in his recollections, and "had not even read my recommendations" of late-1943.

4. Walt W. Rostow, "The Controversy over World War II Bombing," *Encounter*, 53 (Aug.-Sept. 1980), 100-101, disputed the conclusions in Zuckerman's 1943 report as contrary to the data in the body of the report itself, repeated a 1944 OSS observation that relatively-small bomb tonnages could "cut or half destroy a bridge," used simple division to show that Zuckerman's data supported this claim and regression analysis, to confirm it. Rostow, an economist, had been a member of Kindleberger's unit. Zuckerman, "Lord Zuckerman's Reply," *Encounter*, Ibid., 101-102, charged that "Mr. Rostow is tilting at windmills," after showing by probability analysis that Rostow would have been off by one-third [sic] in the extreme case (never contemplated) of trying to block a bridge in one, big saturation raid.

5. F. W. Sallagar, *Operation "STRANGLE" (Italy, Spring 1944): A Case Study of Tactical Air Intelligence* (Santa Monica: Rand Corportation, 1972); Anthony Cave Brown, *Bodyguard of Lies* (London: W. H. Allen & Co. Ltd., 1977, first published 1976).

6. Trains are shunted around, made up, or broken up in these yards. Zuckerman used efficiency as his criterion of successful aerial operations; whereas, in the case of attacks on a transportation line or system, the criterion should have been degree of feasibility; how easily the operations could accomplish their objective of target destruction and consequent military-traffic interruption. I was briefed on this "efficiency" approach, as it was adopted for use by the USAAF-manned MAAF Operations Analysis Unit, at Caserta, Italy, in early 1944, by the late Stanley L. Green, financial analyst, a civilian-specialist member of that staff. Said to be the same as that of the RAF-manned Mediterranean Operations Research Section set up earlier by Zuckerman, it concentrated on plotting and counting (and weighting for proximity to the target's or bomb's epicenter) bomb hits or craters in the attack area, and bomb hits per acre. This statistical scoring and analytical emphasis reveals flawed thinking, in that air-war operations are not mounted solely, or even normally, for materials conservation, target practice, or precision drill purposes. It is self-evident that a high percentage, or even a high density, of bombs dropped within a target perimeter could by itself have no effect whatsoever upon the substantial or complete destruction (in the military sense) of the target, for either a short or long period. Thus, in the case of a 20-track M/Y target, 100 percent bomb-dropping efficiency could turn out to be 0 percent target-destruction efficiency; if (a) the objective was to stop military traffic for two weeks or more, (b) military traffic was only 5 percent of total traffic, and (c) even one track (5 percent of the through tracks) could be put back into operation in a few hours. When the opposing ground forces already were in peninsular Italy, 22 Nov. 1943, MAAF Intelligence Weekly stated that "only about 5 percent of the normal economic rail traffic is sufficient to supply an army in the field" (*MAAF History*, 190). Thus also, in the case of a railway-bridge target, a raid in which just 1 percent of the bombs destroyed a bridge pier and put the whole bridge out of action for two weeks or more could indeed be rated 100 percent on target destruction.

7. All of Zuckerman's arguments on this subject claim that bombing data on these and subsequent operations prove that his target-selection theories, supposedly based on *empirical* evidence, were right; and those of his opponents, supposedly based on *a priori* evidence, wrong. On the contrary, final data on the Rome and Normandy campaigns show that the average M/Y attacked required 3 to 6½ times as many tons to destroy as a bridge.

8. As to costs, the two M/Y campaigns together dissipated 79,600 tons of bombs — just five times the 16,000 tons dropped in the two bridge-bombing campaigns. Other countable costs are shown below, including how in each theater the M/Y campaign undoubtedly delayed the war by up to three months. As to benefits, the M/Y attacks never stopped Italian or French railway

traffic, as their proponents claimed they would. By contrast, rail and road bridge attacks decisively isolated the Rome and Normandy battlefields, as promised, and permitted the quick capture of Rome and entry into "Fortress Europe" north of the Alps, despite the massive movements of German tanks towards, respectively, the breakout and beachhead areas.

9. *AAF History*, III, 153; *MAAF History*, 194. But Zuckerman "likened the [enemy] railway network to a nervous system" and reasoned that a man does not have to be wounded everywhere, if the main arteries [M/Ys] in one part of his body have been critically damaged. (*AAF History*, III, 73; Zuckerman, 240.)

10. Zuckerman, "Air Attacks on Rail and Road Communications," 28 Dec. 1943 (The Zuckerman Report), iv-v (General & Special Conclusions 10, 18), copy on file at OAFH; Zuckerman, 197-199, 202-203, 208-211.

11. *AAF History*, III, 372, 5; *MAAF History*, 189-191. Tedder that day had a completely free hand, as his deptuy and opposite number in the theater, U.S. General Spaatz, had just left for the U.K., to take overall command of American Normandy invasion *and* Mediterranean-theater strategic-bombing forces on 1 Jan. In any case, the Tedder prohibition remained 100 percent effective under his successor, U.S. General Eaker, until superseded (as to mediums and lighter bombers) on 19 March by Operation "STRANGLE," whose terms (in MATAF Bombing Directive No. 2) noted that the "extensive damage" sustained by "principal M/Ys in Central Italy" justified using smaller aircraft against "other interdiction targets" [sic] there and south of Rome. (*MAAF Operations in Support of DIADEM*, IV, Table U).

12. *AAF History*, II, 554-558, 580-581; III, 371-372. Tedder and his professor were now in a position to spring the Zuckerman theories — supposedly so "successful" in the Mediterranean — on the unsuspecting Normandy invasion planners. This they did at once, giving first priority to M/Y bombing. Tedder had had Zuckerman meet RAF Chief of Staff Portal at dinner in the Mediterranean, suggesting that the latter put the professor in touch with the planners on the applicability of his theories to the preparatory phase of the invasion. (Zuckerman, 216-233; 213-214, quoting from "Tedder's autobiography" — no page reference given).

13. *AAF History*, III, 372-376 and notes 2-3; *MAAF History*, 191-195. Tedder and Zuckerman already had seen Air Marshal Slessor, who was at first favorable to their cause, appointed deputy MAAF commander. Moreover, nine months previously, they had picked U.S. Colonel Norstadt, then AAF theater ACS for *Operations*, as outstanding for solving the problems of binational [sic] command (Zuckerman, 175). So Norstadt, now Brig. General, became "Director of *Operations and Intelligence*" of the (binational) MAAF — under Slessor. There he could follow Tedder's lead and pass over ACS for Intelligence's bridge-targeting recommendations, in favor of his old subordinate (Operations Analysis) unit's M/Y-targeting recommendations. Nevertheless, bridge-targeting recommendations — from all echelons of Intelligence in the theater — started reappearing from 5 Jan. 1944 on. They still went unheeded until Slessor, who later admitted that "he had changed his mind" because "experience had invalidated Zuckerman's conclusions," intervened and got Norstadt to compromise by targeting both categories of objectives. (*MAAF History*, 191-192; Sallagar, 34, quoting from Marshal of the RAF Sir John Slessor, *The Central Blue* [London: Cassell & Co. Ltd., 1956], 568.)

14. Sallagar, 7, xiii, 33. "STRANGLE" (19 March - 11 May) blended into "DIADEM" (12 May - 22 June). According to Sallagar (8-9), "The successful [battlefield] interdicition campaign launched from England . . . [and its] contribution to the [Normandy invasion's] success is . . . better remembered, and more often mentioned by historians [than STRANGLE's contribution to the Cassino breakout's success] . . . Yet . . . STRANGLE served as a dress rehearsal for the use of airpower in OVERLORD, and was so recognized in both theaters. . . . Eaker kept in almost daily contact with Spaatz, in addition to sending frequent reports to [AAF chief] Arnold . . . while his deputy, Slessor, took care to keep the RAF chief . . . informed of developments. . . . The successful bridge-busting campaign against the Seine and Loire bridges was . . . advocated by Generals Spaatz and Brereton on the basis of . . . experience during the Italian campaign. . . . As the MAAF historian put it: 'In the battle for Rome, the art of assisting ground advanced by air attack produced its masterpiece to date.' "

15. *AAF History*, III, 358.

16. *Encounter* (June 1979), 86. Pray tell, what does it benefit a ground commander at the front to know that an additional stray bomb has excavated a crater within the periphery of a distant M/Y?

17. Brant's prediction is mentioned among events occurring between 3 and 6 May in *AAF History*, III, 157. OSS/Italy had reported 7 March that "Zuckerman predicted . . . 500 to 1,000 tons probably [would be needed] . . . but was probably talking of at least 50% destruction in a single attack [never contemplated] (*MAAF History*, 194). See also *Encounter* (Aug.-Sept. 1980), 101-102.

18. *AAF History*, III, 74-79.

19. *MAAF History*, 194, quoting from "Air Attack on Bridges and Marshalling Yards in Italy. Is experience prior to the fall of Naples a reliable guide for attack in 1944?" (OSS/Italy report, 7 March 1944). According to Dr. Philip H. Coombs, an economist, coauthor of the report with Russell Dorr, the OSS group at Caserta kept in close touch with Kindleberger's BEW-OSS group in London by weekly pouch. Coombs recalls that the memo I submitted 16 March "was entirely compatible" with his 7 March report, and that the latter "was discussed at one or more staff meetings of MAAF Intelligence officers [I recall that the crucial meeting occurred 17 March], cochaired by MAAF Target Intelligence Section chief Major William F. R. Ballard and 15th Air Force deputy ACS for Intelligence Major Bradford S. Magill, with OSS's Lt. JG Beverly W. Bowie joining in." Two days later, Operation "STRANGLE" directed the bombing of *both* nearby bridges and nearby M/Ys, but only with mediums, so as to isolate the battlefield. Coombs relates that he had been sent to the U.K. by Eaker on 6 March for 10 days, at the instigation of Colonel Harris B. Hull, MAAF ACS for Intelligence, "who was in close touch with Eaker regarding the ruckus over the M/Ys-vs-bridges issue and who sided with our position, to lend support to all our London friends on the key issue of bridge interdiction and to try to get the policy cleared for MAAF." He adds that Tedder by this time was referred to as "Air Vice Marshalling Yards" Tedder (Interview, Lytton with Coombs, 12 April 1981; letter, Coombs to Lytton, 7 Dec. 1981). My 16 March paper recorded that bridge bombing had been proposed originally for many months in Northwest Africa/Italy, by NAAF/MAAF communications-Targets unit chief 1st Lt. Gilbert Raasch; the latter left the 17 March meeting while it was still in progress to say to me (next door): "Did you write this paper? They are going to *adopt* it!" See also *AAF History*, III, 372.

20. *AAF History*, III, 380-381, 377. I consider that 82% (41 out of 50) of the targets in the 175 attacks by mediums against railway lines during "STRANGLE" listed on 377, were bridges. That makes 143 (82% x 175) estimated bridge attacks. Considering that mediums plus heavies dropped 76 tons per attack in 35 bridge raids in Sept.-Oct. 1943 (Zuckerman Report, 56), 50 tons is a fair estimate of average tonnage dropped in these medium-bomber raids. This indicates 7,150 *tons* dropped in these attacks. (The other nine of the 50 targets, all medium-city and small-city M/Ys, might have received 400 tons apiece.)

21. *AAF History*, 393,384. This source apparently omitted aircraft losses during "STRANGLE," but did report 438 planes lost during "DIADEM." As MAAF dropped 33,000 and 51,000 tons, respectively, in these two successive operations, I estimated that 60,000 tons were dropped in the 78 days to Rome's capture. Then I considered that this is 30% of the 200,000 tons dropped — when 2,000 aircraft and 12,000 aircrew were lost — in the similar pre-Normandy-invasion operations lasting 66 days up until D-Day (Brown, 523). I therefore multiplied the latter losses by 30%, to get 600 aircraft and 3,600 aircrew estimated lost in all attacks during the Rome campaign. Next, I divided the 5,000 tons dropped on the ten large Italian M/Ys by an estimated 2¼-ton bombload per aircraft, to get 2,200 estimated sorties flown in these M/Y attacks. Finally, as this is 2% of the 110,000 sorties which I estimated (from these AAF History-cited data) were flown in the Rome campaign, I applied this percent against the estimated 600 aircraft lost in that campaign — and then added two-thirds for the greater anti-aircraft opposition over those repeatedly-attacked cities, to get 20 aircraft (and therefore 200 aircrew) estimated lost in these M/Y attacks.

22. G. A. Harrison, *Cross-Channel Attack* (Washington: GPO, 1951), 224.

23. The average would be *860* (68,000 ÷ 79) *tons*, i.e., over seven

times the bridge average, if we excluded the 3,000 tons (*AAF History*, III, 155) dropped on 14 Southeast-France M/Ys from Italian bases. More important, if we add 120 tons a bridge (4,560 tons) for the 38 bridges over the Loire, etc. destroyed *on D-Day itself* — mentioned below, we have a new total of 8,960 tons dropped on 74 bridges; or over 10% of the total 79,960 tons dropped on both transportation-target systems in this campaign. The dissipation of the almost-90% remainder, dropped on 93 wrong M/Y targets, certainly delayed proper prosecution of the air war for up to three months (March through May). This in turn prevented the early destruction of 14 plants, then turning out 80% of Germany's synthetic petroleum — whose "loss might have been catastrophic to the German," and whose bombing had been planned by Spaatz (78). When followed by more of the same division of effort, diversion of forces, etc., during the balance of 1944, it obviously delayed the end of the ground war in Europe for a substantial period. This followed upon a nearly three-month delay in proper prosecution of the air war in Italy in an immediately-preceding period (1 Jan. - 19 March), when 100% suspension of bridge bombing obviously delayed the capture of Rome and end of the war in Italy.

24. The 71,000 tons dropped on M/Ys, divided by an estimated 2¼-ton bombload per aircraft, indicate about 31,000 sorties flown, which is about 15% of the total 200,000 pre-Normandy-invasion sorties flown reported by Brown (523). Applying this 15% against Brown's reported 2,000 aircraft lost in all operations in this period, gives 300 aircraft (and therefore 3,000 aircrew) estimated lost in these M/Y attacks.

25. Charles J. V. Murphy, "The Unknown Battle," *Life* (6 Oct. 1944, overseas ed.), 35f.

26. Brown, 702, quoting from M. R. D. Foot, *S.O.E. in France* (London: HMSO, 1966), 397.

27. In other words, if you want a positive answer, just ask a prisoner of war, "Didn't our bombing of your M/Ys cause you more damage than our bombing of your bridges?" Just ask your railway experts, "Wouldn't you rather not have a thousand tons of bombs dropped on each of your M/Ys?" Just ask your Operations Research/Analysis faithful, "Isn't it more fruitful to bomb M/Ys than to bomb bridges?" Thus, one can serve badly an air commander, supreme commander, war cabinet, prime minister, or president by composing and asking — unintentional though it might be — the wrong, determining questions.

Postscript

After writing this article, I learned from Kindleberger that Walt W. Rostow, *Pre-Invasion Bombing Strategy; General Eisenhower's decision of March 25, 1944* (Austin: University of Texas Press, 1981) had been published, that it reviewed the Normandy end of the argument in greater detail, and that it contained "a great deal of discussion of strategic attack against oil, which Zuckerman opposed." Upon examination, the work also ascribes a further delay in prosecuting the war to the interruption and dilution of the oil-industry attack, due to the M/Y attacks having diverted and postponed the employment of heavy-bomber forces needed for the strategic oil campaign's vigorous prosecution from the start.

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